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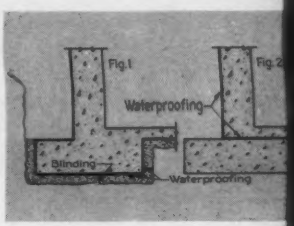
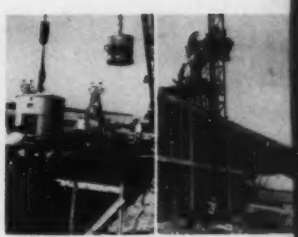
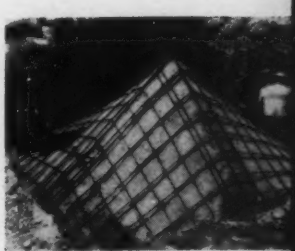


Waterproofing Is An Art. A practicing architect discusses the details, specifications, materials and methods necessary for successful waterproofing.



Handling Concrete. In reponse to many requests from readers, the lead article in next month's issue of Concrete Construction will take up the important subject of what factors to consider in selecting equipment and methods for moving concrete from the truck mixer to formwork.



Thin Shells Go Underground. A brief description and some comparative costs on a new concept of foundation design which shows great promise.

Over 35,000 copies mailed. Edited for all who are concerned with quality, job placed concrete (including prestress, tilt-up, lift slab, and thin-shell)—its specification, production, handling, forming, reinforcing, placing, finishing, and curing: *Concrete Contractors, General Contractors, Engineers, Architects, Industrial Construction and Maintenance Men, Highway Engineers, Ready-Mixed and Prestressed Concrete Producers.*

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Three members of the administrative team at the PCA laboratories talk over a problem in the office of *Dr. A. Allan Bates*, vice president in charge of research and development. From left to right, *Hubert Woods*, director of research, *Dr. Bates*, and *Douglas McHenry*, director of development.

REVOLUTION IN CONCRETE

A FULL-SCALE REVOLUTION is being spearheaded from the Portland Cement Association's Research and Development Center in Skokie, Illinois, on its tenth birthday—a revolution in concrete that affects everyone connected with the concrete industries, including the men who build with this versatile material.

Here's how Dr. A. Allan Bates, PCA's vice president for research and development, sums it up: "When we moved into this new laboratory ten years ago, we had one overall specific mission: to help convert concrete construction from an inefficient, weather-vulnerable, poorly controlled operation to an exact, efficient and predictable construction procedure. The progress made in this direction in the past ten years has been revolutionary. The contributions we have made are by all odds the most important achievements of these laboratories.

"When we built the present Laboratory Administration Building in 1949, it took six months to construct the forms and six more months to place the concrete. Most of this work was done by day laborers who had little or no conception of the science or techniques of concrete. Even with all the competent and extensive supervision they had, it was still essentially a hit-or-miss project. Now, just ten years later, concrete making is on the verge of becoming an exact science. The same job, done today, would make use of lighter, stronger, more attractive precast structural units. The concrete would be produced by exacting factory methods under close scientific supervision. The design would be radically different, the construction time much shorter, the appearance more attractive. All these things have come about in a single decade, and they're only a taste of what's ahead. We're grateful for the part we've been able to play—and will continue to play—in them."

There's an almost tangible feeling of optimism and excitement at the PCA laboratories. But excitement, of course, isn't enough. Even a research laboratory must be measured by results, and the results are there, too—many of them of primary importance to every concrete builder. Before we examine specific results, however, let's take a quick look at what has happned to the PCA research facilities during the past decade.

The physical growth at the laboratories gives evidence of the increasingly important part being taken at Skokie in expanding the knowledge and technology of cement and concrete. At the time of its opening in June, 1950, the laboratory employed about 80 people; now it requires more than 200 to

carry out its program. More than a million dollars' worth of new equipment ranging from a complete mobile highways laboratory to an electron microscope, have been added. And two major laboratory buildings have been completed in the last three years at a cost of about $3 million.

The fire research laboratory added 32,000 square feet of floor space; the structural laboratory added 24,000 square feet. To accommodate these new buildings, provide for additional field experiments, and guarantee room for growth, the original 15-acre research and development tract has been expanded to 37 acres.

What does all this mean to the concrete industry? "Prosperity," firmly says Dr. Bates. He explains this way: "New construction in 1959 was $55 billion or 11 percent of the gross national product. By 1970, new construction will account for 14 percent of the gross national product and will increase to $95 billion. During this period, concrete's share of the construction market will approximately double—as a result of startling new developments in concrete, principally in the structural field."

PCA scientists, however, emphasize the urgent need for educating the people who use cement and concrete. Typical was this comment:

"We've had a considerable backlog of conservatism to overcome in this structural revolution in concrete. Architects, engineers and builders hesitate to use a new design or material until they know how it will perform. In the concrete business, there is reluctance to alter the status quo."

greatest hope for future: *structural concrete*

The area in which the status quo is being shaken most violently is—understandably—the area of greatest advancement: structural concrete.

"At the present time, about 5 percent of the structural material going into American buildings is concrete and the remainder is steel," says Eivind Hognestad, manager of the PCA structural development laboratory. "Within the next ten to twenty years, I expect the ratio to become almost half-and-half."

Brave words these—and prosperous words, too, if they're to be accepted. On what does Dr. Hognestad base his optimism? There are three major developments supporting the revolution in structural concrete. They are:

1. The trend toward higher strength steel and high quality concrete. This means turning away from the idea of massive concrete structures to concrete beams, girders and panels that are smaller, lighter, stronger, and more economical. This has been made possible by the advent of high strength steel — which was first developed in Europe and brought to this country by research and development workers—with the PCA laboratory a principal leader. Here it was changed metallurgically to suit American conditions—again with PCA laboratory leadership. Although high strength steel is but a small part of the reinforcement steel now being sold, scientists estimate that within ten years, high strength steel (i. e., 60,000 to 75,000 psi yield as contrasted with the 40,000 common today) will make up 80 percent of the total.

2. Exciting design concepts, known as ultimate strength and limit design. These theories—which PCA has helped establish along with other organizations—more accurately and realistically project the properties of structural concrete as they really are, in contrast to straight-line theories formulated about 1900 and in general use until the current revolution in design.

3. Narrowing the "area of ignorance" known as the safety factor in concrete construction. The whole safety concept is being critically examined. As concrete is designed more realistically, the need for unnecessarily large and expensive safety factors is disappearing. The resulting buildings will not be any less safe, but—as a result of exact knowledge—the consistency of safety will actually be improved.

Like a light turning on, many of the people who build with concrete and establish codes for its use are recognizing and embracing these revolutionary new concepts of structural concrete. This had to

Here, a scientist examines crack development in a reinforced concrete beam loaded to failure in the million-pound compression testing machine in the PCA laboratories. The steel I-beams are used to distribute the load on the concrete girder.

happen before its potential could be realized. And it is happening. "How fast," asks Hognestad, "can human beings change their minds about old design practices? I just returned from an industry meeting where many of the oldest and best known people in the construction business were asking themselves this question. Not once did I hear the argument: 'We've done it this way for 50 years; why should we change?'

"But," he continues, "we have a terrific education job ahead of us. Most American builders are going to have to change their viewpoint on a very basic matter: the cost of engineering. New concrete design practices are likely to be expensive at first in terms of engineering time. A builder looking for an immediate bargain won't get the kind of engineering thinking that will make use of advanced concrete design techniques. But I emphasize immediate, because—in the long run—good and expensive engineering will save him money. This is going to be a difficult idea to sell, and it will take time. Although we can expect the cost of design in concrete to go down steadily as these new techniques become more common, there is still a considerable educational job to be done."

Typical is the bridge engineer who was recently considering prestressed girders for a job in his state. He carefully measured the depth of the girder, then announced it would have to be a minimum of 2 feet in width. When it was explained to him that new design practices permitted cutting the width of such a girder to a top of 9 inches, he simply refused to listen. "It is our policy," he said, "to insist on a minimum of 2 feet in width and that's what it will be."

Such thinking, however,, is going by the board, and those builders, contractors and concrete producers who recognize this fact and act on it will be in the forefront of their business as a result.

PCA research scientists feel that a whole new concept of design in concrete will be reflected in the building codes by 1961 or 1962.

"It's rather difficult," says Hognestad, "to support conservative views in these days of the atom and moon shots. This same sort of scientific revolution is taking place in structural concrete, and the world climate is now ready to accept and act on it. Builders who ignore the exciting new possibilities in concrete are going to be commercially dead ducks."

"I see the mental cobwebs disappearing throughout the construction industry," added Dr. Bates. "There are many encouraging signs—especially in design thinking, where it's now possible to find real excitement and imagination. The individual thinker has the backing of science, and we're going to try to make this even more so in the decade ahead. We proved our confidence in our own ideas by designing and building our two new laboratory structures with concrete structural members and panels using high strength steel. They were the first such buildings in the nation.

"Concrete has traditionally been used in the most inefficient manner of any building material," Bates continued. "Its widespread and growing use under these circumstances is a real tribute to its great versatility and strength. The ultimate in prestressing is the most efficient use of concrete. But before we can arrive there, we must tread many a tortuous mile in between. There's a vast gap between the complete use of prestressing and the present uses of concrete. Code acceptance must be gained bit by bit on the basis of incontrovertible experimental data; and the necessary production of high strength steel must be warranted and obtained. In between will be a steady progression of the use of reinforced concrete, designed by new methods and making use of new steels."

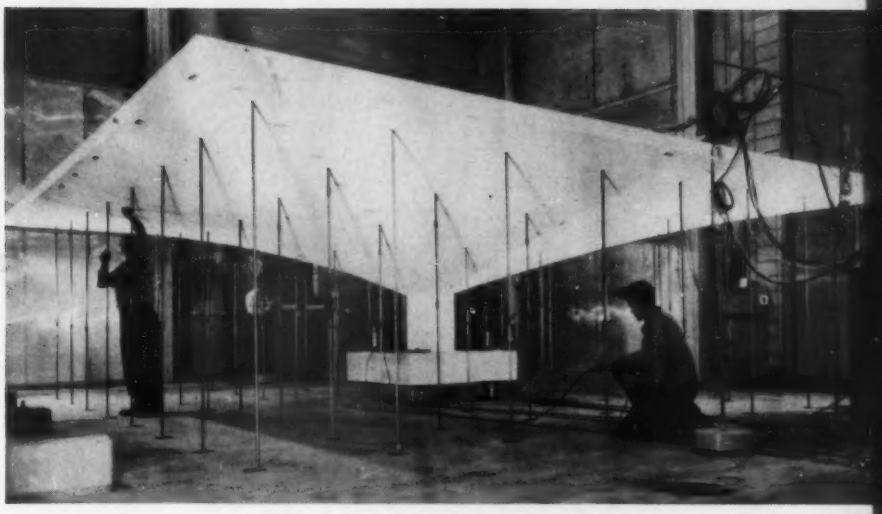
What do these new structural concepts mean in practical terms? To take one illustration: it is now theoretically possible to build a concrete skyscraper as high as any in the world. A few years ago, fifty stories was the absolute limit—and that would have required a whole basement full of concrete to support it. Using new design concepts, the concrete skyscraper can be built perhaps more economically than one of competing materials.

"The greatest concrete market of the future, by far," says Dr. Bates, "is urban rehabilitation and the mass structures that will be necessary to bring it about. This is coming—and soon. With new design concepts, we're ready for it. You've seen what is happening in bridge building. Before too many years, we're going to see the same change in the structural business, too."

highway research concentrates on subbases

There is so much excitement at Skokie over progress in the structural field that it tends to take the edge off other areas of research and development of vital interest to the concrete builder. The concrete highway, the former star performer (and still very much a headliner), has continued to receive a great deal of attention from research scientists. A decade ago, concrete paving was under severe attack, but the development of air entrained concrete saved the day. With the knowledge and use of air entrained concrete now widespread, scientists have turned their primary attention to other matters in the paving field.

The problem of the pumping of highway pavements has absorbed the efforts of a whole coterie of Skokie scientists almost since the laboratory first opened its doors. It was discovered by PCA highway engineers, among others, that a layer of granular material beneath a concrete pavement frequently prevented the pumping of the subbase. Laboratory scientists then took over the job of determining what kind and how much granular material should be used. In general they have



As the horizons of structural concrete expand, more model testing is expected to be undertaken in the PCA laboratories. Here, technicians ready a thin shell roof model for stress tests in the new PCA structural laboratory.

discovered that a minimum thickness of granular subbase will do the job; tests on 3, 5 and 8 inches have shown little difference in performance in preventing pumping. Tests showed further that a thicker granular base had little effect on the strength of the pavement—that once a uniform subgrade was obtained with enough granular material to mitigate pumping, any additional strength would have to come from the pavement itself.

Granular subbases have proved an effective answer for pumping. But, as is true of virtually any such discovery, there are certain conditions where the remedy isn't complete. At the present time, scientists and engineers working on highway problems consider a cement stabilized granular subbase the most effective possible. In some instances, cement stabilization reduces subbase costs, by permitting use of substandard materials, rather than trucked-in fill. California, which has used cement stabilized base for years, builds unreinforced concrete pavement over such subbases with good success. Stabilized bases make it easier for contractors to work, cutting down on construction costs, and also adding to the strength of the completed pavement.

At present, scientists are centering their attention in this area on the problem of drainage and the erosion of many different kinds of soil used to build subbases.

concrete resurfacing explored

Several years work on concrete resurfacing of paving slabs has brought to light two essential facts: (1) when a concrete surface is properly cleaned, new concrete can be effectively bonded to it with a simple mixture of sand and cement grout; and, (2) the performance of resurfaced slabs is about the same as that of monolithic slabs of the same total thickness.

The opportunities for resurfacing concrete paving are increasing. Because of unfortunate alignment of old highways, it is difficult to resurface most of them. With new roads, however, this will be possible when and if they need it. The big hitch will be the cost—which is still considerable. In the meantime, however, resurfacing appears both practical and useful for airfield runways that need widening and strengthening—and to bail contractors out of difficulties caused by construction errors.

Typical of the latter was an Air Force construction job in the south where new concrete paving froze on top while it was being placed. The Air Force ordered the contractor to remove the entire pavement, then relented and agreed to let him remove the top few inches and resurface it. The resurfacing job was successful and has performed satisfactorily.

Work is also underway on the testing of prestressed concrete road panels. Researchers would like to conduct their tests under actual road conditions, but haven't been able to afford such an ambitious program. In the meantime, a number of prestressed slabs placed on a wide range of subbases behind the PCA laboratories, are being tested under varying load conditions. A few generalizations have come to light as a result of these studies. Deflections are high on prestressed pavements; thus stabilized subbases are virtually mandatory. Thickness can be reduced about 50 percent for comparable strengths with prestressed concrete. The present high cost, however, makes prestressed pavement feasible only for airfields or other installations where extremely great strength is required.

What's ahead in paving? "Railroads," says Earl Felt, head of the transportation development section, "still put their rails down on wooden ties. Many European railroads have found prestressed concrete ties to be better, and a prestressed concrete tie developed mainly by the research labora-

tories of the Association of American Railroads currently is being tested in quarter-mile sections on the Atlantic Coast Line and Seaboard Railroads. We'll also continue to investigate subbases, adding constantly to the knowledge of what's best beneath concrete pavement." Other possibilities include heated pavements, especially in cities where ice removal is a serious problem, continuous reinforcement to eliminate joints in concrete pavements; and increased use of color in concrete roads—for eye comfort and to mark turn-offs and other directional guides more clearly.

other activities underway

We've considered the two major areas of PCA research and development work of primary interest to the contractor: structures and paving. There are dozens of other activities underway at the Skokie laboratories, and they merit more than passing mention. Let's look at a few of them briefly:

1. A mobile laboratory is now available to test highway pavements in any section of the country—thus extending PCA research throughout America's network of highways. The mobile unit includes: (a) a semi-trailer combination which can be weighted to simulate any desired testing load; (b) a laboratory trailer housing a wide assortment of research equipment. This mobile laboratory is filling a decided need in highway research—particularly for investigating pavements that couldn't be simulated in the Skokie laboratories.

2. Studies are continuing on cement-aggregate combinations that unexpectedly produce nondurable concretes. Knowledge acquired from basic research into the chemical and physical properties of cement paste has been applied to these "cement-aggregate reaction" problems. Result: common properties in the aggregates are being isolated, and it is expected that potential trouble-making combinations can soon be accurately predicted. This and other research work on aggregates now in progress will greatly increase the availability of aggregates for concrete making throughout the country.

3. Plastic forms to impart glossy or textured surfaces to concrete have been developed in the PCA laboratories. These plastic form liners can produce concrete of delicate design, color or texture—and their use in building projects is growing steadily.

4. Fire tests on structural concrete members in the new fire research center are turning up the first specific scientific data available on certain types of concrete structural members from which precise fire safety specifications for concrete can be drawn. These tests are also providing considerable information on the design of concrete structural members for maximum resistance to extreme heat.

5. A program of study is underway on coatings to protect concrete from the attack of acids found in silos, sewers, chemical plants, dairies and similar installations. Studies of a large number of proprietary compounds have indicated that there is a wide range of effective protective coatings for concrete. "The problem," points out George Verbeck, who heads up PCA's applied research section, "is the method of application. We haven't yet found a system of application that will entirely eliminate pin holes through which the acids can work."

The most recent method of application investigated is also the most hopeful one. PCA scientists are working with the glass industry to perfect an inexpensive glass fiber coating that would be applied in overlapping units to effectively seal off pin holes. The system is now under study; the outlook is optimistic.

past accomplishments—and a look ahead

What are the most important developments to come out of the PCA laboratories in the past ten years? Scientists prefer to talk in areas rather than specifics. But, in general, they agree that the most important areas of advancement (not in the order of their importance) include:

1. High strength steel
2. Improved methods of concrete design, including ultimate strength and limit design
3. Knowledge of the characteristics of lightweight aggregates and lightweight concrete
4. New sense of coordination of materials
5. Growth of quality control in materials
6. General acceptance of new developments in air entrained concrete

Other areas of great progress mentioned frequently include the furtherance of shell structure design, concrete pavement resurfacing, shrinkage control and improved design of pavement subbases.

All this progress is not, of course, due to the unilateral efforts of PCA scientists—as each of them is quick to point out. This has been a cooperative revolution, and PCA has shared the leadership with such allies as the technical commitees of the American Concrete Institute and the American Society of Civil Engineers and some 40 American colleges and universities and 29 trade associations and public agencies. And, of course, it is the technical experts and field engineers of PCA's Promotion Division who are responsible for the implementation of useful data. Much of the work undertaken by the laboratories is to meet the needs of these engineers who from daily contact with their fields know much about what is necessary to further concrete's growth.

What do all of these accomplishments add up to? On the basis of the evidence available at Skokie and many discussions with scientists and technicians there, five guideposts seem to point quite clearly the direction in which concrete construc-

Probably the most important development in concrete paving was air entrained concrete. Its benefits in a climate with severe cycles of freezing and thawing are dramatically illustrated in these two test specimens from the Naperville, Illinois, test plot of the Long Time Study of Cement Performance in Concrete. Placed less than five years ago, non-air entrained specimen (at left) has deteriorated badly while air entrained specimen shows no ill effects.

tion will travel in the years ahead:

1. The great burgeoning increase in the use of concrete will be in the structural field. Spectacularly expanding use of structural concrete as a result of revolutionary new design concepts making concrete lighter, stronger and more economical, may outstrip what even its most optimistic advocates predict. The concrete producer, designer and builder who recognizes this fact and gets in on the ground floor can expect to prosper along with this new structural material.

2. Almost every element of the concrete industries stands to benefit by the resurgence of structural concrete. Production of structural members will probably be divided about equally between job-site factories operated by contractors and large concrete factories where rigidly controlled operations will turn out consistently high quality products.

3. Concrete highways will increase somewhat in the absolute, but not necessarily in relation to other materials in the total amount of new highways constructed. The tendency to lighter cars in the years ahead may finally result in much cheaper passenger car roads, augmented by heavy duty freight highways. In this case, concrete would be a necessity for the freight roads, but might be used in lessening amounts for passenger highways.

4. Concrete paving can be expected to expand in other fields—particularly airport runways. As aircraft become larger and heavier, stronger runways will be needed until eventually probably all runways will be built of prestressed concrete. But it is doubtful if prestressing will be used generally in highways. The cost is high in relation to need—unless we begin building the freight highways mentioned above.

5. The keynote of the future is quality. Sloppy concrete and haphazard techniques will no longer be tolerated. More and more, concrete will become an exact material, made by exacting engineering methods. Within this new concept of concrete, there will be little place for the marginal operator. Small plants will continue to operate, particularly in communities of 100,000 or less, but the increasing emphasis on high quality and good engineering will force them to keep on their toes to keep in business.

Here, then, lies both the danger and the opportunity. Concrete producers and concrete contractors are at this moment on the ground floor of one of the most exciting construction opportunities in many years. But to take advantage of it, they must become expert in their business. They must reduce concrete to an exact science and understand how and why it is being used. Those who understand this fully and act accordingly will grow and prosper, as never before, in the years ahead.

Concrete in 1960 is truly the material of opportunity. Much of this is due to the dedicated work in the past decade at the research and development laboratories of the Portland Cement Association. The bandwagon is on its way. Concrete producers who jump aboard now should have a long, prosperous and exciting ride. **END**

PERLITE[1] INSULATING CONCRETE

By RICHARD E. BARNES[2]

PERLITE INSULATING CONCRETE consists of an appropriate mixture of portland cement, perlite aggregate and water. Its weight can be varied in the range of 20 to 50 pounds per cubic foot, depending on the mix design selected. This is in comparison to sand and gravel concrete which weighs 140 to 150 pounds per cubic foot and the 60 to 120 pounds per cubic foot weight of expanded slag, shale or clay.

Because of its exceptionally light weight, perlite concrete is not considered a true structural concrete. However, it is the strongest concrete in its weight class and has more than adequate strength for floor fills, light structural roof decks placed over formboards, and metal lath or paper backed wire mesh, and makes an economical and versatile insulation fill over metal decking and structural concrete. It can also be sprayed as a fire retardant backup for metal curtain walls.

On flat roofs, the thickness of the perlite concrete can be varied to provide drainage slope as well as insulation. When placed over permanent forms, such as paper backed welded wire mesh, ribbed metal lath or various formboards, perlite concrete combines the functions of roof deck and insulation in one low-cost slab that needs no additional insulation. Perlite concrete screeds smooth without steel troweling and makes an excellent base for bonded built-up roofing. It can also be used as non-load bearing fill in bridges, tunnels, and other types of construction.

The most common use of perlite insulating concrete is in roof deck construction, since it offers excellent insulation plus greater strength, rigidity and fire safety than other roof insulation materials. In addition, perlite concrete is adaptable to most design requirements since it can be placed monolithically on flat, uneven, curved or sloping surfaces. While a 2-inch thickness of 1: 6 mix provides insulating value equal to 1 inch of good quality insulation board, a 40-inch thickness of regular sand and gravel concrete would be required to obtain this same value.

While perlite insulating concrete may be mixed and delivered in the same equipment and by essentially the same methods as sand and gravel concrete, there are considerations that must be given to the order of addition of materials and to the time of mixing to assure correct concrete

[1]Perlite is not a trade name but a petrographic term for a naturally occurring siliceous volcanic rock which is surface-mined in the Rocky Mountain region of the United States. When crushed and flash heated to above 1,500 degrees F., it expands to form lightweight, non-combustible particles of cellular structure. This material has an average weight of 8 pounds per cubic foot which is approximately 1/12 the weight of sand.

[2]Technical Director of the Perlite Institute, Inc.

TABLE 1: Typical Mix Designs and Physical Properties of Perlite Insulating Concrete

†Dry Concrete Properties										Mix Proportion by Volume				Field Tests
mix ratio	* oven dry density (lb. per cu. ft.)	* compressive strength (psi at 28 days)	** thermal conductivity "k"	* coefficient of thermal expansion (per unit per °F)	* tensile strength (psi at 28 days)	* bond strength to steel (psi at 28 days)	* modulus of elasticity in compression (psi at 28 days)	* indentation strength 1" disc[1] (psi)	* indentation strength ½" ball[2] (lb)	cement (sacks)	Perlite (cu. ft.)	water (gal. per sack cement)	air entraining agent *** (pints)	*†wet density as poured (lb. per cu. ft.)
1:4	36	440	0.77	0.0000061	75	83	248,000	485	210	1	4	9	1	50½
1:5	30½	270	0.64	0.0000055	50	53	158,000	335	130	1	5	11	1¼	45½
1:6	27	180	0.58	0.0000048	40	23	120,000	260	105	1	6	12	1½	40½
1:7	††24	130	0.54	0.0000045	30	—	94,000	220	85	1	7	14	1¾	38
1:8	22	95	0.51	0.0000043	20	—	69,000	185	70	1	8	16	2	36½

*Based on impartial laboratory test data of Robert W. Hunt Co. Engrs. under sponsorship of the Perlite Institute. Average density of the aggregates used was 8.0 lb. per cu. ft. Strength data based on ASTM Type 1 Portland Cement.
**From report dated April 8, 1953, of Armour Research Foundation of Illinois Institute of Technology.
*** Available from Perlite Institute members.
(1)Compression applied as concentrated load until initial failure.
(2)Maximum load required to imbed ball to ½ its diameter.
†Data subject to modification due to variations in mixers and job conditions.
†† All data for this density is interpolated.

FILE: Lightweight Concrete

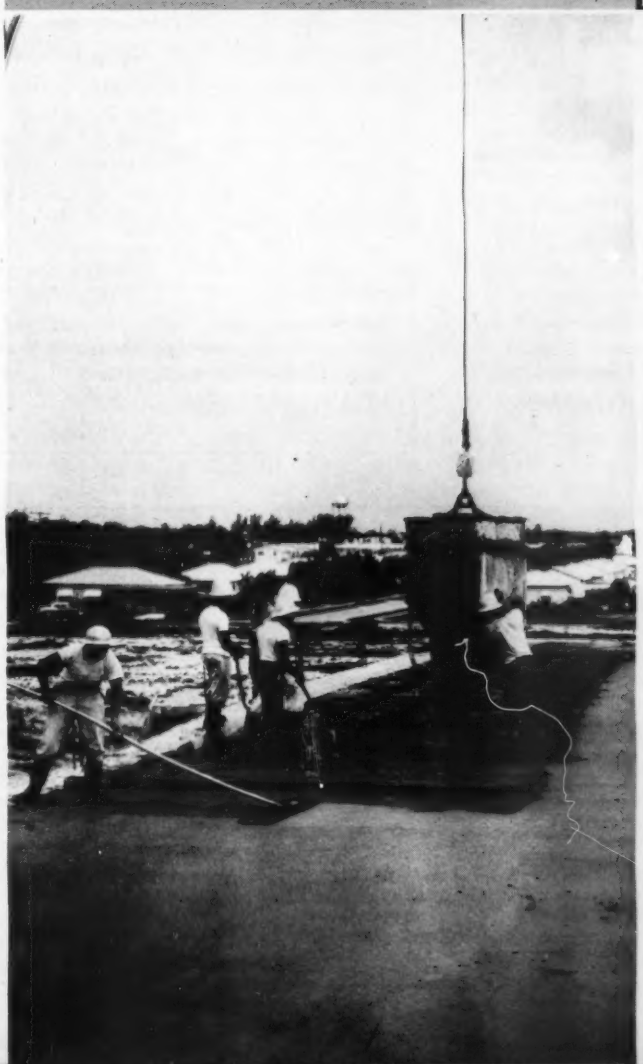
Although not considered a true structural concrete, here's a material for which more and more uses are being found because it is the strongest concrete in its weight class.

TABLE 2

Materials for One Yard†

mix ratio	cement (sacks)	Perlite (cu. ft.)	water (gal.)	air entraining agent*** (pints)
1:4	6.75	27	61	6¾
1:5	5.40	27	59½	6¾
1:6	4.50	27	54	6¾
1:7	3.85	27	54	6¾
1:8	3.38	27	54	6¾

NOTE: For explanation of reference marks see notes for Table 1.



These ready mixed concrete trucks (above) are delivering part of some 200 cubic yards of perlite insulating concrete for the shopping center pictured below, where the material was used in part for roof fill. This single project has a total roof area of 8½ acres—just one example of the volume potential in supplying insulating concrete.

properties and adequate yield. An air entraining agent is used in nearly all applications to improve the workability and to control water content and insulating value of the concrete.

The most common perlite concrete is the 1 : 6 mix, which is normally used for roof decks. A 1 : 4 mix will provide greater compressive strength, while the 1 : 8 mix offers greater insulation value. Refer to Table 1 for typical mix designs. The quantities of materials per cubic yard are as indicated in Table 2, although these data may be slightly modified due to variations in mixers and job conditions.

The use of the correct amount of air entraining agent of the proper concentration is of vital importance in successful perlite concrete construction. The air entraining agent produces countless tiny air bubbles in the concrete which reduce the density, increase the yield and contribute to the insulation factor of the hardened concrete. Care should be taken in mixing perlite concrete to insure that the proper amount of agent is used. Excessive entrained air may reduce the strength of the concrete.

The step by step transit mix operation is as follows:

1. Determine the load of the mixer.
2. Add to the mixer the correct amount of water for the load.
3. Add the correct amount of air entraining agent and cement to the mixer and mix until a slurry is formed.
4. Add the required number of bags of perlite aggregate.
5. If the drum is rotated during transit, it should be at slow speed for no longer than 5 minutes.
6. Upon arriving at the job site, mix at top speed for at least 5 minutes and not more than 10 minutes.
7. Discharge in normal manner after checking the wet density for conformance to specification range.
8. Rotate the drum at idle speed when discharging last of load to insure complete discharge of concrete.
9. Do not wash out drum between loads.

If desired, the drum can be charged with water, air entraining agent and cement at the batching plant, and the perlite aggregate can be added at the job site, mixing at high speed until the desired density and consistency is reached.

Care must be taken to insure proper mixing time for the perlite insulating concrete. Using the correct amount of water as specified, the perlite concrete should have a maximum slump of approximately 7 inches when properly mixed. It may very well appear too wet by normal standards. However, if the mix appears too dry or stiff, the mixing time has probably been too short and mixing should be continued until the desired plasticity is attained. Extra water and under mixing may reduce the yield.

Yield may be checked at the job site by simply obtaining several unit weights of the fresh concrete. The ready mix truck can be equipped with a 10-pound scale and a gallon container. Multiply the weight per gallon by 202.5 to obtain the weight per cubic yard. Divide this weight by the weight per cubic yard of all ingredients and multiply by 100 to obtain percent yield. It is quite common for yield to run higher than 100 percent, which means an economical concrete.

Because it is completely inorganic and has the permanence of concrete, perlite insulating concrete cannot rot or decay, is not damaged structurally by water, resists attack by rodents and vermin, and thus lasts for the life of the building. With these selling advantages the contractor and his ready mixed concrete supplier have an opportunity in the years ahead to open up an almost entirely new market for concrete. END

Readers who would like to have additional information on the subject of perlite insulating concrete may request it by circling No. 641 on one of the reader service cards in this issue.

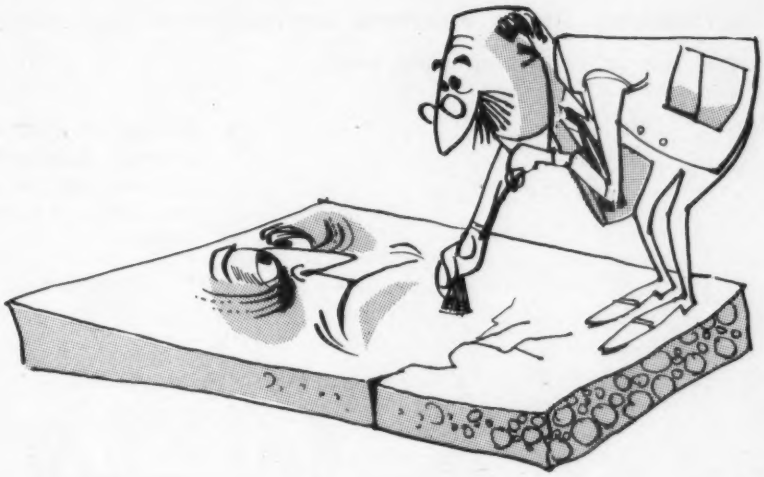
Some Outstanding Perlite Concrete Structures

The **Alcoa Building** in Pittsburgh, referred to by its design engineers as "the lightest office building of its size ever built." All exterior walls consist of 4-inch thick perlite concrete faced with aluminum. Its 30 floors contain 310,000 square feet of rentable space above the first floor, yet its lightweight construction permitted a saving of 6,500 tons of structural steel.

The world's largest sub-zero storage warehouse constructed for **Continental Freezers of Illinois, Inc.**, in Chicago. More than 10,000 cubic yards of perlite concrete was used to insulate the floor and roof deck. A differential of 115 degrees has been maintained between the inner and outer surfaces of the perlite concrete.

The **Kentucky State Fair and Exposition Center**, opened in 1956. Seventeen acres of perlite insulating concrete was laid on roof decks over exhibition halls and the coliseum to assure fire safety and durability.

DIAGNOSING SUMMER CONCRETE ILLS



EXCEPT FOR FLASH SETTING and one or two other troubles caused by high temperatures, the ills that beset concrete placed during the summer months are less obvious at early stages than those encountered in cold weather. Concrete surfaces exposed to direct sunlight and high winds dry out rapidly; as a result, they fail to develop adequate strength to prevent dusting. Premature stiffening makes adequate finishing impossible, with accompanying adverse effects. Crazing becomes more prominent. When floors improperly concreted in the summer are exposed to traffic, the toll of poor practices shows up inevitably in the form of crazing, spalling and dusting. Walls, roofs and other building components also soon begin to show the telltale signs of incorrect procedures.

Unlike many necessary cold weather concreting practices, preventive summer measures are comparatively simple and cost little. Essentially, they consist of steps aimed at keeping the water/cement ratio at the desired level. The temptation is great for workmen at the job site to water concrete on a hot day to make it easier to handle. Ready mixed concrete almost unfailingly contains the optimum quantity of water when the truck pulls up to the job site. If the truck must wait before the concrete can be discharged, the ready mix may stiffen appreciably in the hot drum. Then water (often more than is needed) is added. If the concrete is placed on a dry subgrade which absorbs water from the mix, or curing is insufficient or ineffective, the resulting concrete will be weak and lack durability.

To avoid troubles in summer concreting, observe the following rules:

1. Have enough men to place and finish the concrete rapidly.
2. Dampen the subgrade, reinforcement and forms.
3. Don't use accelerators.
4. If needed, use a retarder.
5. Don't keep the ready mix truck waiting.
6. Shade the concrete after placing.
7. Protect freshly placed concrete from dry winds.
8. Cure thoroughly for at least 3 days (7 days for floors).
9. Protect test cylinders from loss of moisture.

Observing these few rules can spell the difference between a job to be proud of and one which will produce nothing but headaches. As heat and wind velocity increase and humidity decreases, the necessity for observing these rules will become more important. For the most part what is called for is not any additional expenditures. The secret is in careful pre-concreting planning and competent supervision. END

BYPASS THE CONTRACTOR

. . . by following simple directions anybody can place concrete

1 Look the job over carefully. Analyze all requirements, and choose materials judiciously. Don't overstock.

2 Mix cement, sand and aggregates thoroughly, taking care not to use too much water. It will weaken concrete.

3 Spend a little extra time finishing. Remove foreign objects.

4 At this point, a suggestion: **CONTACT NEAREST CONTRACTOR.**

ACI Members Hear Vibration Described As One of Greatest Advancements in Concrete Technology

Other papers discuss techniques for restoring deteriorated surfaces

AMONG THE HIGHLIGHTS of the recent 56th annual convention of the American Concrete Institute held in New York City was a series of four related reports on successful techniques of restoring deteriorated concrete and a single paper covering broad aspects of the improvement of concrete through vibration. The restoration symposium was sponsored by ACI Committee 201, under the chairmanship of Hubert Woods, research director for the Portland Cement Association, while the report "Consolidation of Concrete" was compiled by ACI Committee 609 under the chairmanship of Joseph J. Waddell of Knoerle, Graef, Bender & Associates, Chicago.

consolidation of concrete

Listed among the advantages of consolidating concrete by vibration were the following: lowered cost of concrete through ease of placement and by reduced cement content; greater concrete density and homogeneity; greater strength; improved bond with reinforcement; greater bond at construction joints; greater durability; and reduced volume change or shrinkage. The savings achieved and the improved qualities in concrete are now so well established that vibration has become an accepted practice in practically all types of concrete work, the report noted. That so many improvements can be attributed to one innovation makes vibration one of the greatest advancements in concrete technology.

Consolidating equipment may be divided into five general categories, each type designed to accomplish a specific purpose: (1) immersion vibrators, inserted directly into the concrete; (2) form vibrators, attached to the forms or molds; (3) vibrating screeds or pans, applied to the surface of concrete; (4) surface tampers; and (5) miscellaneous tampers and shakers.

For most structural concrete, vibration is most efficiently performed by means of standard immersion vibrators.

It was noted that adequacy of vibration is judged mainly by surface appearance. Embedment of large aggregate, general leveling of the batch, apparent blending of the batch perimeter with concrete previously placed, and general cessation in escape of large bubbles of entrapped air are evidence of adequate vibration. Particularly important is vibration at proper depths and spacing.

A 3-inch maximum slump is ample for properly vibrated structural concrete in forms but what may be regarded as a need for wetter concrete in many quarters is better satisfied by more thorough vibration. Not only is superior workmanship in placing better assured with more vibration, the report pointed out, but the quality of concrete can be improved because the water content can be lowered with less slump. The opportunity to obtain concrete of superior quality, and possibilities for mix economy, can be lost if modern vibration equipment is not fully utilized to place concrete of these lower slumps.

The report also explained that allowing the vibrator to penetrate completely through the layer being placed and into the underlying layer helps to weld the two layers thoroughly together. The revibration of the previously placed concrete is beneficial because it rearranges the aggregate particles and eliminates entrapped water from under the aggregate and reinforcing steel, with consequent full contact between the mortar and coarse aggregate or between the steel and mortar. The resulting concrete is stronger and more watertight.

Air bubble holes can be substantially eliminated from vertical formed surfaces by additional vibration, which may be as much

FILE: Vibration

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as twice that normally required for consolidation and prevention of honeycomb. Vibration should be increased by closer, deeper and longer penetrations. Form vibration also aids materially in reducing air bubble holes.

Thin slabs such as sidewalks and floors are best consolidated by means of a surface vibrator, the report stated.

Care must be taken that vibrators are used to consolidate concrete that has been properly placed, and that they are not used to move concrete about in the forms.

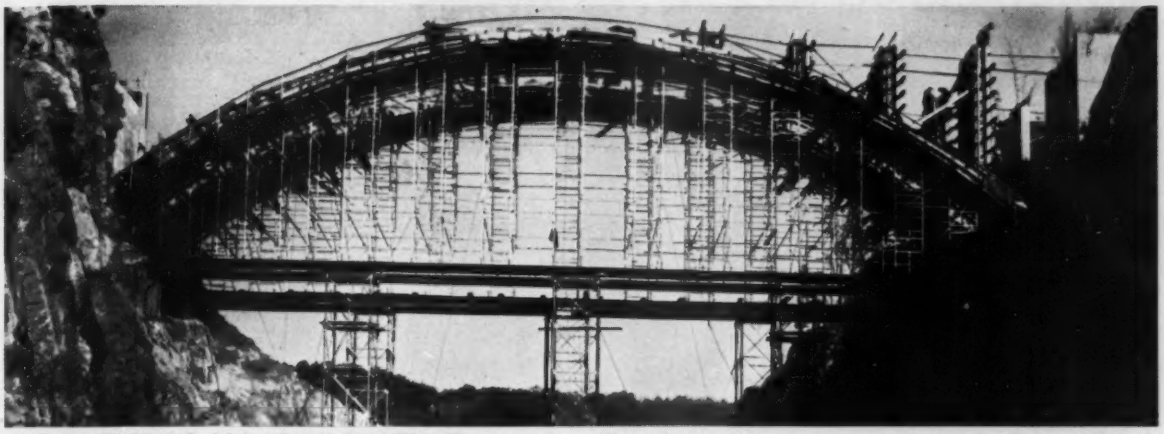
There are few imperfections in concrete placing workmanship, the report concluded, that cannot be corrected by additional vibration. The proper use of vibration will allow the placement and consolidation of concrete in difficult locations and at comparatively low slumps. High slump concrete will not insure good results; in fact, it will foster separation and unsatisfactory results. The modern concrete vibrator is a remarkable tool with great potential for making the use of lower slump concretes entirely practical. These lower slump concretes provide better quality and greater economy than have been obtained generally in the past, and full use of vibrators can be made to gain these benefits without fear of over-vibration.

conventional repairs

These points were emphasized under the heading of conventional techniques of repairing concrete: good concrete repair or restoration must be thoroughly bonded to the older concrete; must be sufficiently impermeable to prevent moisture reaching underlying older concrete; must, after drying, be free of shrinkage cracks through which water could reach the supporting concrete; must be resistant to freezing where this is a factor in weathering; and should match surrounding concrete surfaces.

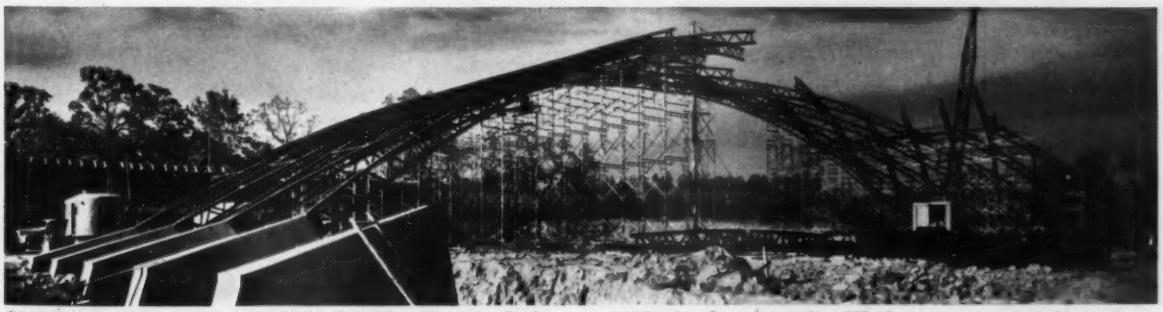
On new or restoration work, all

Shoring Methods . . . *by* PS CO.



TWO-UP SHORING FOR HEAVY BRIDGE—For the new, 143′-long concrete bridge at Hogback Dam, Riverton, Conn., PS CO. Extra Heavy Duty Shoring is first assembled in 6 towers, 48′-high to carry a total load of 32,000 lbs. per leg. I-beams are set on top. Then "Trouble Saver"® 4′-wide Heavy Duty Shoring frames are arranged atop the I-beams. Frames support 9,000 lbs. per leg, imposed by columns and two ribbon arches 8′-wide by 1½′ to 3′-thick, 34′ center height. White Oak Excavators, contractor.

LONG, HIGH, EDGE-BEAM SUPPORT—Shoring of long, concrete edge-beams, 22′-wide by 4′-thick, varying from 140′ long by 70′ high to 150′ long by 75′ high, is easily accomplished with standard "Trouble Saver"® Sectional Steel Shoring. Frames of various heights are used to match the curve of the beams. Gilbane Building Company, contractor, for the first fully mechanical Post Office, Providence, R.I. Building is to be 420′ by 300′.



CRIBBING FOR STEEL LAMELLA ROOF—For the Ladue H.S. Auditorium, "Trouble Saver"® Steel Shoring is rapidly assembled in towers to form temporary cribbing during erection of steel girders of the lamella-type roof. Shoring towers, with frames spaced 5′ apart, are placed to hold girders during positioning by one crane. Workers secure opposite ends to adjoining members already placed. Steel arches are 252′-long, abutment to abutment, center height 50′. Christina Constr. Co., gen. contr., Kroeger Erection Co., steel erectors.

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unsound concrete should be removed completely. It was also recommended that excavations be shaped so as to make the replaced material as secure as possible, and that surfaces be cleaned and moistened for maximum bond. For cleaning, sand blasting should be preferred to scrubbing with a wire brush.

Although moistening of older concrete is usually advised before bonding, it was observed that on joint surfaces possibly more permanent bond can be secured when these surfaces are dry at the time they are overlaid with fresh concrete. The effort formerly expended on moistening before the repair is transferred to more water curing afterward.

For the restoration of weathered spillways, piers and other hydraulic structures, reinforced air-entrained concrete was recommended as "probably preferable to shotcrete." Other factors affecting bond, permeability, cracking, durability, and appearance of concrete repairs were also detailed.

patching of pavements

Long lasting results in the patching of distressed areas of concrete pavements with bonded concrete were also said to be largely dependent upon the preparation of the old concrete surface.

Sited was one group of tests which showed that cleaning and slight roughening of an old sound surface with hydrochloric acid developed acceptable bond in the range of 300 to 500 psi. Chipping the old surface with an electric chisel improved bond, but the most effective tool for mechanical cleaning and for removing unsound concrete was the Tennant machine. Sand blasting was not particularly effective in these tests.

Spalling at the joints, frequently caused by poor jointing design or improper construction, was described as "probably the most common defect in concrete

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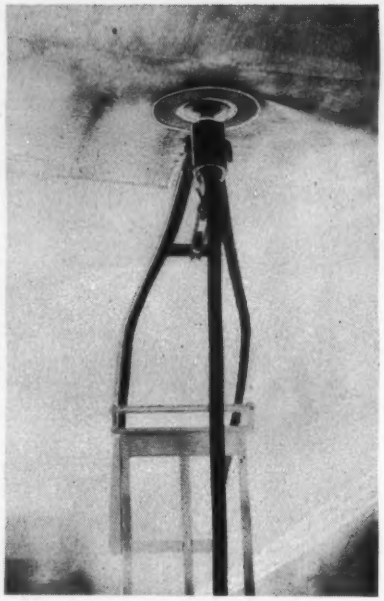
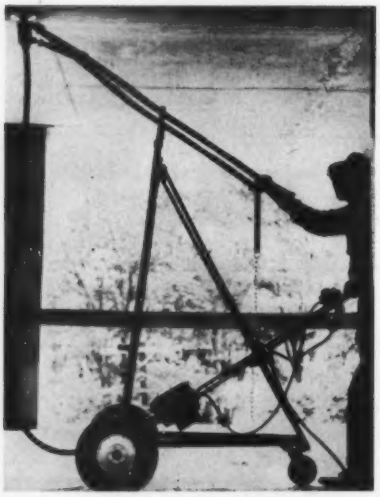
More and more building specifications require finely finished concrete ceilings. Because of this new requirement, Stow Manufacturing Company has developed the Stow CG Ceiling Grinder—a special machine designed to grind off form marks and fins, cut off nails, and smooth the entire surface.

With this machine, one man can average 4,000 square feet per day. Simple to operate, it pushes along like a baby carriage.

To operate the Stow Ceiling Grinder: (1) The operator first sets the pivot arm at about a 45° angle, then adjusts the grinding disc to proper height by lifting up on the rubber-gripped handle in the center. A ratchet arrangement automatically locks it in position at the desired height. (2) A slight pressure is exerted on the grinding disc by the spring and chain assembly at the opposite end of the pivot arm. (3) A turnbuckle is used to adjust the wheel to the most desirable angle for grinding. For ordinary grinding, the disc should be flat against the ceiling, but for cutting nails and removing fins, it works better at a slight angle. A spring arrangement built into the bearing housing supports the grinding disc and absorbs shocks, thus preventing any gouging. Once the machine is adjusted, the operator just pushes it along.



FOG OF CONCRETE DUST



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All three models have a 1 HP totally enclosed motor operating at 3450 RPM. The disc is a 9" Bayflex of cotton fibrous material with a silicon carbide abrasive bonded with resin.

The Stow CG Ceiling Grinder can also be used for grinding walls by attaching a handpiece or anglehead to one end of the flexible shaft.

Stow Manufacturing Company makes a complete line of portable electric flexible shaft grinders for both wet rubbing and dry grinding walls. Send for your copy of Stow's Concrete Grinding pamphlet, which gives the proper speeds for both wet rubbing and dry grinding. For more information on Stow Concrete Grinders, contact your Stow distributor or send in the coupon below. Stow Manufacturing Company, Binghamton, N. Y., makes a complete line of concrete vibrators, rotary trowels, screeds and grinders.

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pavements." If air entrained concrete had been used, the spalls are hard, durable concrete and the shearing surface makes a good base for a bonded concrete patch. Many pavements made of non-air entrained concrete still exist, however, and spalling at joints is also associated with concrete disintegration. Here, the base concrete may not be in good condition and considerable preparation will be required before patching with bonded concrete.

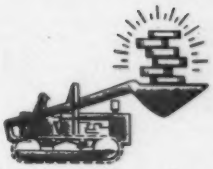
In addition to good surface condition of the old concrete, high quality grout and concrete, first class workmanship in placement and compaction, and proper jointing and curing were also described as essential for lasting bond of relatively thin layers (1 to 3 inches) to old base concrete. Suggested techniques covering these procedures were detailed.

prepakt method

First used in 1938 in the strengthening and stabilizing of the concrete lining of Muir tunnel on the Santa Fe Railroad near Pittsburgh, California, the prepakt method has found many applications in the restoration of old concrete and masonry structures. It has also gained favor for certain types of new construction, such as underwater work, where the proper placement of conventional concrete is difficult or impossible.

Prepakt is essentially a concrete of gap grading which is produced by first placing the coarse aggregate in the forms, and then pumping a sanded grout, sometimes referred to as intrusion mortar or prepakt grout, into the voids of the aggregate mass. In the repairs of many old stone masonry and concrete structures by the prepakt method, neat cement grouting is also carried out for the purpose of improving structural stability and reducing leakage.

Bond strength between new prepakt concrete and old conventional concrete is much high-

Want a bigger share  of the new construction contracts in your area?

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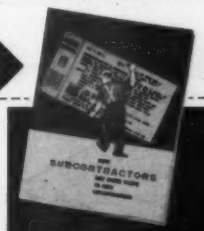

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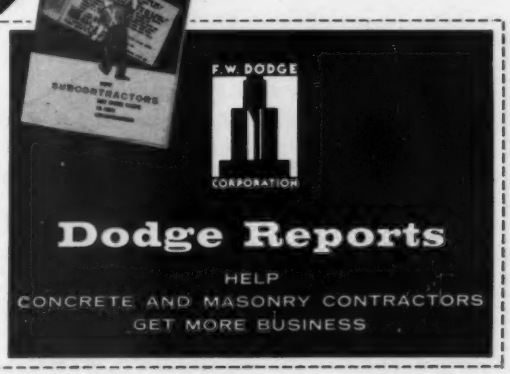

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er than that obtained between new and old conventional concrete. This is probably due to the grout being applied under pressure. Prepakt's wetting properties and its fluidity is much greater than that of the usual mortar constituent of ordinary concrete.

Another property in which prepakt excels is low drying shrinkage, which is likely to be only about one-sixth as great as the usual mortar applied pneumatically and less than half as great as that of conventional concrete. This low drying shrinkage, thought to be due to point-to-point contact of the pieces of coarse aggregate, also promotes greater crack resistance.

Also, based on laboratory tests and performance of field structures over a period of years, prepakt concretes of suitable materials and good workmanship resist weathering action caused by freezing and thawing better than conventional concretes. Later-age strength of prepakt concrete is also considerably greater.

repairing with epoxy resins

Adhesives and binders for highway use are formulated of low-viscosity epoxy resin, a plasticizer and a curing agent. Depending on the viscosity at the time of mixing, a certain amount of finely ground inert filler such as talc or silica can also be added.

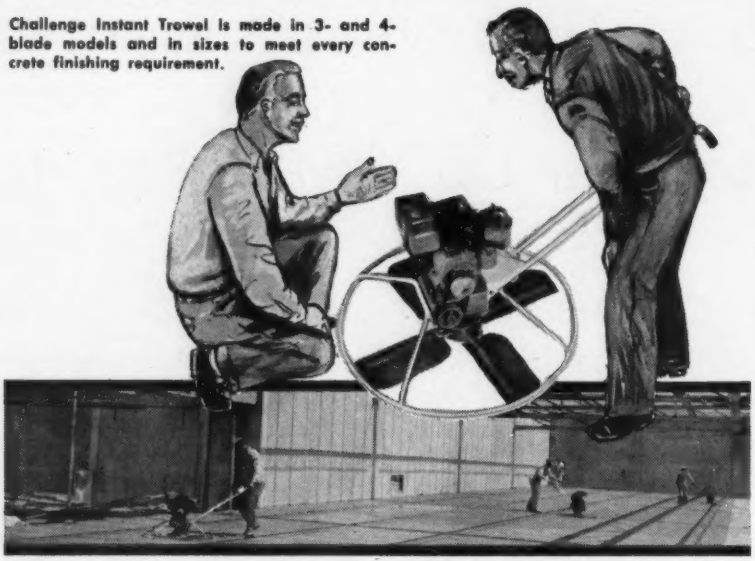
For the repair of highways and bridges under traffic, quick hardening is desirable but this complicates the mixing and handling of the compound since rapid hardening formulations also have a short pot life. In general, small batches must be mixed and applied promptly. The choice of curing agent (generally organic amines) and the percentage used determines the pot life and the setting time.

In patching spalled areas with epoxy mortar or concrete, the binder used by the California Division of Highways contains no filler and has a pot life of about 20 minutes at 70 degrees F. Under favorable conditions, the repair has been opened to traffic within 3 to 5 hours. In cool weather, metal channels are placed over the repaired area and they are warmed with torches.

Epoxy concrete is considered economical to use in fairly large volume on heavily traveled structures such as the San Francisco-Oakland Bay Bridge. But if substantial repairs are involved and if traffic conditions permit, it is more economical to use portland cement concrete bound to the original work with a coating of epoxy adhesive.

As in other concrete repair work, the surface to which an epoxy adhesive is applied must be scrupulously cleaned, preferably by sandblasting. Concrete may be damp but must be free from surface moisture when the adhesive is applied. END

Challenge Instant Trowel is made in 3- and 4-blade models and in sizes to meet every concrete finishing requirement.



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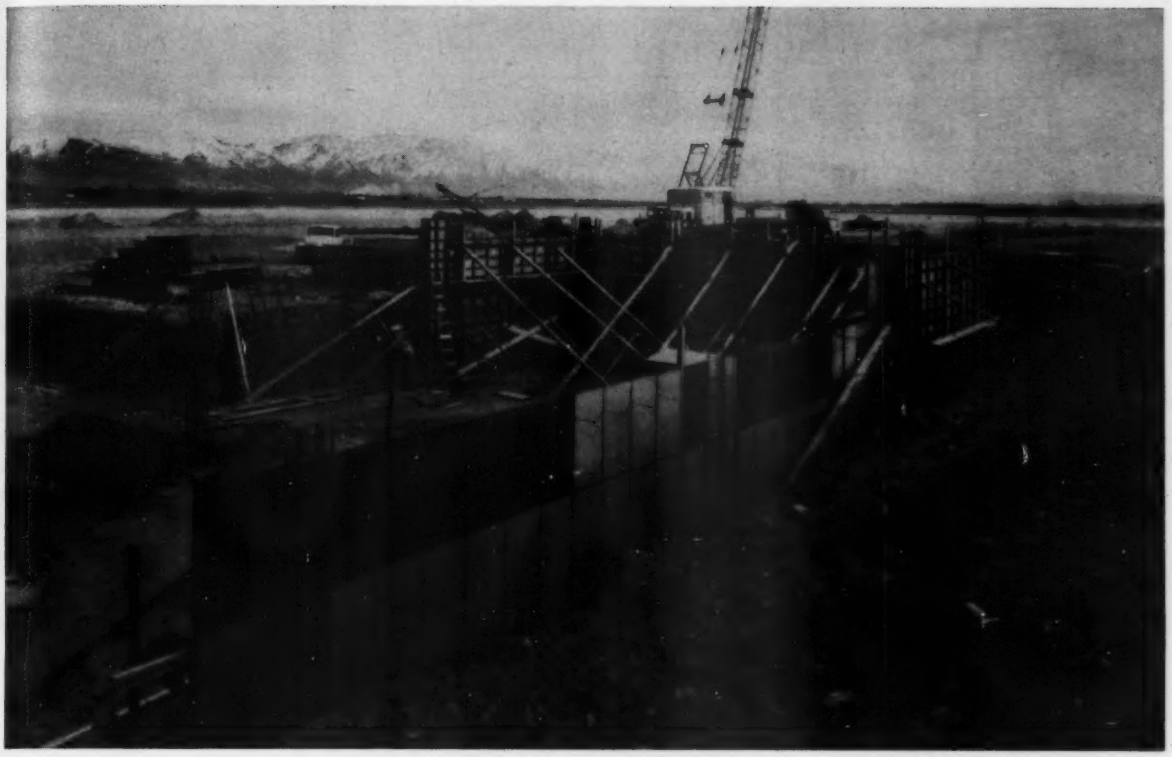

Jet Age Concreting with Symons Steel-Ply Forms

Cuts Costs on Salt Lake Municipal Air Terminal

A combination of sound engineering, imaginative forming and efficient pouring methods have proved that even a jet age terminal building can be constructed rapidly and at moderate cost.

It was vitally important that costs be held to a minimum. Costs to the contractor on the basis of 150 re-uses of the forms amounted to about 1½c per square foot. After four months work, the cost of handling and stripping the forms had dropped about 25 percent, compared to previous methods of handling heavier job-made forms. Also, costs were progressively reduced with each use of Symons Steel-Ply Panels.

Designed for Salt Lake City Corporation by the architectural-engineering firm of Ashton, Evans and Brazier.

Christensen Bros., Salt Lake City, the builders, studied a number of forming systems. Symons Steel-Ply Forms were selected based on the recommendation of Earl Jensen, President of Contractors Equipment & Supply Company (Conesco), Salt Lake City.

To give itself every possible advantage, the company first ordered the Symons Forming System on a rental basis. It was complete with corners, adequate fillers for forming curved walls, ties, and all necessary parts of the hardware system. The selection proved so good that practically all of the forms were purchased before the option-to-buy period had expired.

Symons Forming System was used successfully in all parts of the building . . . 12" thick reinforced-concrete basement walls . . . pile cap foundations . . . 20x26, 16x26, and 10x12 inch concourse beams . . . square passenger concourse columns . . . forming a double-flared, curving wall with varying heights.

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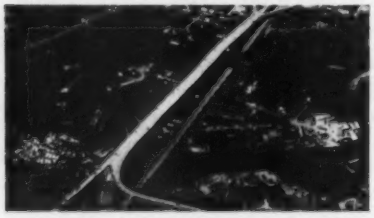
Weld-Crete is the patented, job-proved liquid bonding agent which enables you to *permanently* bond new concrete, or cement plaster, *directly* to any other structurally sound surface no matter how smooth! No costly, time-consuming surface preparation. Just apply, let dry, and pour or trowel new concrete. Ideal for new construction, remodeling, repairs . . . *ramps, floors, precast shapes, driveways, highways, walls, machine mounts and pads.* Weld-Crete has equal bonding permanence all climates, all surfaces, all sorts of conditions. When used with quick setting cement topping you can lay new floors, ramps, driveways one day and run heavy truck traffic over them the next. Get fact-packed literature from your Building Materials Dealer, see Sweet's File, or write us direct. Address Larsen Products Corporation, P.O. Drawer 5938, Bethesda, Maryland.

Typical **WELD-CRETE** Applications



GRANVILLE ST. BRIDGE, VANCOUVER, BRITISH COLUMBIA—One of the largest 8 lane bridges in North America. Here Weld-Crete was applied to bridge surface to bond cement dividing strips. Now, over 4 years later, bonds are as good as new. *General Contractor:* Dominion Bridge Company.

SEVEN CORNERS SHOPPING CENTER, FALLS CHURCH, VIRGINIA—During construction of this 600,000 sq. ft. structure, initially only part of floor was poured and floated to a smooth finish. Areas in which show windows would be added were poured as base slab only. Slab was coated with Weld-Crete. After store fronts were custom-built, delayed toppings of 1" to 1½" thick were poured with assurance of permanent bond to base slab. These toppings were then finished with asphalt tile, wood, or finish flooring of lessee's choice. Designed and constructed by The Kass Realty Co. of the Kass-Berger Organization under direction of J. Franklin Groff. *Concrete Contractor:* Moses-Ekco.

Circle 612 on reader service card

letters

reinforcing in driveways

Sir:

This refers to the article on "Home Driveway Construction" in the January 1960 issue of Concrete Construction.

In your discussion of reinforcing you refer to an American Concrete Institute study which indicates that to obtain any noticeable amount of crack control there is needed 0.8 percent of steel based on the cross-sectional area of the concrete slab. The ACI study referred to is entitled "Continuous Reinforcement in Highway Pavements" and was published in the December 1958 Journal of the ACI. This report defines continuous reinforcement as follows:

"It seems logical, therefore, to define a continuously reinforced pavement as one of such length and with adequate reinforcement continuously placed, that a considerable central portion is fully restrained against longitudinal movements due to seasonal temperature changes. If one arbitrarily states that the length of the restrained central portion shall be equal to at least that of the end portions which respond to seasonal temperature changes, then one could say that a continuously reinforced pavement is one in which the length of individual slabs is not less than 1200 to 1500 feet. This length is of course a minimum limiting value and, theoretically at least, there would be no maximum limitation on length."

All joints, except expansion joints at the beginning and end of the project or at intervening structures, are omitted in this type of pavement. As a result, many closely spaced cracks occur. The expected crack interval is from 3 to 10 feet and since the success of these pavements depends on holding the cracks closed, it is necessary to provide a large percentage of steel.

Continuously reinforced pavements, as discussed in the ACI report, are not intended for driveways or pavement slabs of a similar nature. They are intended only for the concrete pavements subjected to large volumes of heavy wheel loads and where long sections can be constructed without interruption by intervening structures.

Jointed slabs are more practical as well as more economical for driveway construction. Steel reinforcement for a jointed slab is determined on the basis of the "subgrade-drag formula" which is expressed by $A_s = \frac{FLW}{2f_s}$

in which

- A_s = effective cross-sectional area of steel per foot of width—sq. ins.
- L = distance between free joints—ft.
- w = weight of slab—lbs. per sq. ft.
- F = coefficient of subgrade friction
- f_s = allowable working unit tensile stress in the steel —psi

In the above formula the weight of slab per square foot (w) is calculated on the basis of concrete weighing 12½ pounds per square foot per inch of thickness. Experiments have shown that the coefficient of subgrade friction (F) may vary from less than 1.0 to about 2.0. A value of 1.5 has been arbitrarily adopted as satisfactory. The allowable tensile stress in the steel (f_s) is taken as 40000 psi for welded wire fabric.

Assuming a driveway slab 5 inches thick the required steel area (A_s) will vary with the length of the slab. Computations by means of the above formula give values of .035, .047 and .058 sq. in. per foot of width for slabs 30, 40 and 50 feet long, respec-

CONSTRUCTION OF CAUSEWAYS and fill-islands eliminated need for cofferdams for those piers which are in the stream. A stiffleg derrick, mounted on barge when over water and on track for land operations, lifted the heaviest and highest bridge sections, saving expensive falsework. 200′ boom carried 60′ jib.

JOB-BUILT RIG, operating on railroad tracks, solved the problem of long hauls (one bridge is 5,060′, the other 4,585′). The 95 lb. concrete for the 5¼″ thick decks was produced by using 1,210 lbs. of ⅜″ aggregate and only 405 lbs. of ¾″ aggregate in each cu. yd. of mix.

SAME SUBSTRUCTURE FORMS were used on both bridges. Cranes, as well as the derrick, placed concrete for the tall piers.

Design by Bridge Division, South Dakota Dept. of Highways. Substructure contractor, Massman Construction Co., Kansas City, Mo. Superstructure contractor, J. F. Beasley Construction Co., Chicago.
Photos by EN-R.

95 lb. concrete saves steel in bridge decks

Use of lightweight aggregate produced a 95-lb. per cu. ft. concrete for the roadways of two high-level bridges over the Missouri River in South Dakota. This saved approximately 3 million lbs. of floor dead load in one bridge and 3⅓ million lbs. in the other, permitting a substantial reduction in the weight and cost of structural steel.

This was one of the construction economies which, together, saved taxpayers $2 million on these look-alike bridges, the two longest spans between the Mississippi and the Pacific. Other factors in this big saving were the maximum reuse of concrete forms and duplicate fabrication and erection of superstructure trusses and girders for both bridges. Two sizes of concrete forms were used. The smaller forms were used 22 times, relined 5 times; the larger forms were used 13 times, relined 3 times.

Trouble developed when concrete for the substructure of the first bridge was plant-mixed and hauled to the site in 2-yd. buckets. Hot weather and rough roads caused premature setting, even with retarder added. This was eliminated by pouring the superstructure of the first bridge, and all concrete in the second bridge, with truck mixers of certified design, capacity, mixing speed and water control accuracy.

You have a right to insist on this Rating Plate. It certifies compliance with the high industry standards which are maintained for your protection by the

TRUCK MIXER MANUFACTURERS BUREAU

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Pacoima, Calif.
Willard Concrete Machinery Co., Ltd.
Lynwood, Calif.
Worthington Corporation
Plainfield, N. J.

Circle 622 on reader service card

Time makes all things worse.

Demetrius

Now, there's a switch on one of our pet proverbs. Don't agree with it, entirely. Seems a pretty gloomy way of looking at things. Still, there must be some truth in it. The fellow who first said it lived over two thousand years ago . . . so it would seem that quite a few people down the centuries considered his thought worth repeating.

It's certainly true that time takes its toll on concrete. But some concretes age better than others . . . and calcium chloride can make the difference. There are a number of reasons for this, but the most important of them is the fact that mixes containing chloride are workable with less water. They have greater density, greater final strength. They're harder . . . less subject to surface wear. And they set *faster!*

Time? Calcium chloride beats it every which way. For full facts on why . . . and how much . . . write for our free folder, "Better Concrete in Every Season with Wyandotte Calcium Chloride." *Wyandotte Chemicals Corporation, Dept. FS, Wyandotte, Michigan. Offices in principal cities.*

Wyandotte CHEMICALS

MICHIGAN ALKALI DIVISION

HEADQUARTERS FOR CALCIUM CHLORIDE

Circle 624 on reader service card

tively. These areas can be furnished by No. 9, No. 7 and No. 6 gauge wires on 6-inch centers.

In the application of the subgrade-drag formula certain minimum wire sizes and maximum spacings are recommended as a matter of good practice. Minimum sizes of welded wire fabric should be No. 10 gauge for basement floors and sidewalks; No. 6 gauge for driveways and filling stations; and No. 4 gauge for industrial floors on ground.

A good rule for spacing, regardless of type or size of member, is that the spacing of reinforcing steel members should not exceed twice the thickness of the slab and in no case should it be greater than 12 inches. It is customary to limit the spacing to a maximum of 6 inches in slabs less than 6 inches thick.

There is ample evidence throughout the country that steel reinforcement, distributed in the slab in accordance with these recommendations, does provide crack control. And it will do it more effectively than increasing the slab thickness since no matter how thick the slab is made, it will lose its load-carrying capacities unless the crack is held tightly closed.

In this connection I would like to discuss the statement with respect to wire reinforcement that "no claims are made for increasing the structural strength." This erroneous conception stems from the fact that the steel used in slabs-on-ground is so much smaller in amount than the steel required in a structural or free-span slab. The reason for this can be readily explained.

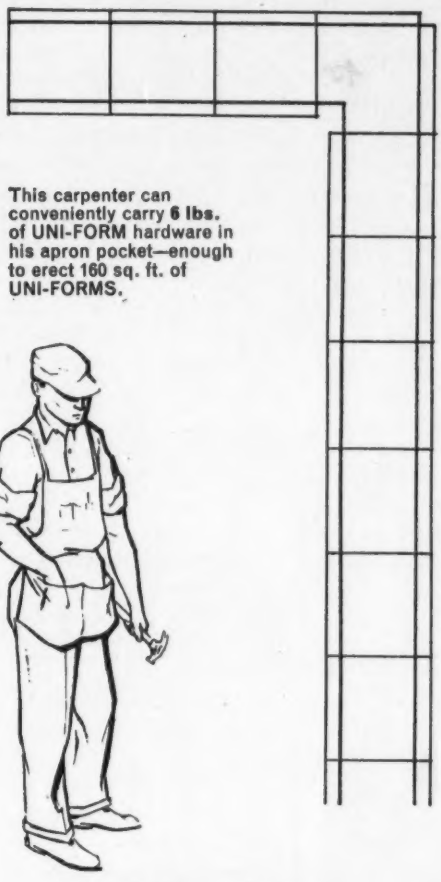
The structural action of a ground slab in supporting loads is essentially different from that of a free-span slab. If a crack occurs anywhere within the span length of a nonreinforced free-span slab, the flexural resistance of the member is completely destroyed. Sufficient steel is, therefore, needed to provide the tension reinforcement necessary to prevent collapse.

On the other hand, in a nonreinforced concrete slab resting on the ground, whether used as a floor slab inside a building or a pavement or driveway slab, the occurrence of a crack, while it creates no hazard of collapse, does materially reduce the load-carrying capacity of the slab. The crack creates a slab edge which does not previously exist, and under load the edge of the slab is fundamentally weaker than its unbroken interior. But one edge is no more than half as strong as the slab was before the crack occurred.

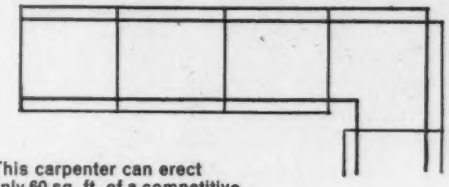
Therefore, in order to conserve the original load-carrying capacity, it is only necessary to control the crack in such a manner that the two crack edges will deflect simultaneously rather than independently. Thus the load that passes over the crack is supported by the two slabs instead of one. This can be effectively accomplished if the rough faces of the crack are at all times held in tight interlock. Accordingly, reinforcing steel is required only in sufficient amount to prevent the faces of the crack from separating when subsequent contraction occurs. This amount is considerably less than that required to carry the loads applied to a structural or free-span slab which is supported only at the ends of the slab rather than being uniformly supported over the entire area as is the case with a slab-on-ground.

The mere fact that the lightweight reinforcing used in driveway slabs holds tightly closed any cracks that may form is very definitely a structural benefit. It maintains the load-carrying capacity of the slab which would otherwise be lost if the crack were free to open. As long as the

WHICH PREFAB FORM SYSTEM OFFERS MORE PRODUCTIVE FORMING TIME PER DAY?



This carpenter can conveniently carry **6 lbs.** of UNI-FORM hardware in his apron pocket—enough to erect 160 sq. ft. of UNI-FORMS.



This carpenter can erect only 60 sq. ft. of a competitive prefab system's panels with the **6 lbs.** of hardware he carries in his apron. **Extra trips for hardware means less productive forming time.**

UNI-FORM SYSTEM

Carpenters can form more contact area per hour with UNI-FORM Panels than they can with any other prefab form system. The reason? It takes less hardware — in most cases, 50% less — to form a given contact area. And UNI-FORM hardware **weighs less, costs less,** and is easier to install.

EXAMPLE: **6 lbs. of UNI-FORM hardware — 128 Tie Keys — are required to install 32 UNI-FORM Ties (4 keys per tie).** 32 Ties are required to erect 160 sq. ft. of UNI-FORM Panels.

Cost of hardware required to install 1 UNI-FORM Tie: **LESS THAN 4¢.**
(Tie Keys are re-usable)

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A leading competitive prefab form system requires 2 tightening wedges and 2 connecting bolts per tie installed. **In 6 lbs. of this hardware, there are only 24 sets of wedges and bolts — enough for 12 ties.** 12 ties will assemble **only 60 sq. ft.** of this system's panels.

Cost of hardware required to install 1 competitive tie: **36¢.**
(Wedges and Bolts are re-usable)

WHICH PREFAB FORM SYSTEM GIVES YOU FASTER FORM ERECTION AND LOWER COSTS? Want more information about UNI-FORM Panels and the advantages they can bring to your concrete forming? Write today for complete details.

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Circle 623 on reader service card

cracks in the slab are held tightly closed they are harmless. However, if the cracks are permitted to open excessively, as is the case with nonreinforced slabs, they undergo progressive deterioration which leads to failure and costly repairs. Increasing slab thickness without providing steel reinforcement will not overcome this tendency.

HENRY AARON
Chief Engineer, Reinforced Concrete Pavement Division
Wire Reinforcement Institute
Washington, D. C.

improving bidding practices

Sir:

With a population of 180 million people there should be a market for $67.5 billion of construction at the 1960 inflated prices. The prospects now indicate a possible construction volume of $55 billion, some of which is not absolutely essential public and semi-public made-work to maintain employment. Is it any wonder that price-cutting is rampant when everyone is trying to get at the public pork barrel to survive, in a subsidized society living on borrowed money?

The surest way to wreck the economy is by allowing the prevailing cycle of price-cutting to continue. The large buyers and sellers are still active, but how long can this last when the purchasing power and credit of the small buyer has been destroyed? The present pseudo prosperity is extended on borrowed credit at the expense of future generations. These loans are being insured by unlimited confiscatory taxing power. To prevent ruination, all government expenditures should be limited to current income from natural resources without taxation.

The construction industry is becoming extremely competitive due to the Public Works Program in which under open bidding the award is essentially to lowest bidder. Competition has become so acute that the contractors are quoting prices 5 to 20 percent below normal costs.

As the result of wasteful inflationary malpractices, business has now turned into a depressed buyers' market. Unless the decline in prices is halted by economic measures, unemployment and stagnation will result. More public and semi-public works in open low bid competition will only aggravate the situation by reducing profits to losses, thereby creating more bankruptcies and depression.

The answer to bid-peddling, shopping and cut-throat competition is the same as it was 40 years ago—the issuance of a uniform Purchase Requisition indicating the quality and quantity of material and labor required as an integral part of the bidding and contract documents. This would expose errors and reduce malpractices that are now destroying profits.

Purchase requisitions would prevent risky and reckless bidding, thus stabilizing profits and business. It would also eliminate the needless expense of contractors and sub-contractors preparing repetitious surveys, costing billions of dollars annually in wasted effort.

It is within the power of architects, engineers and contractors to change conditions by demanding Purchase Requisitions on public and private projects, as the basis of bids and contracts, for the protection of buyer and seller.

G. SZMAK
Executive Secretary
Construction Surveyors Institute
New York, N. Y.

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The only versatile paving machine on the market today! Lays up to 10' per minute of finished curb and gutter curb alone, combination gutter, curb and walk, median strip or drainage gutter. Saves ⅓ to ½ over old hand methods. Paves any curb and gutter section. Tamps, strikes-off and compresses concrete. Increases concrete yield. The original paver. Our 12th year serving the construction industry. Send for literature.

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Cut costs because workers can handle and set up more forms per day with no strain. Magnalite Curb and Gutter Forms are made of tough magnesium alloy. A 12" x 10' form weighs only 47 lbs.—one third the weight of steel. More forms transported with lighter equipment. Send for data.

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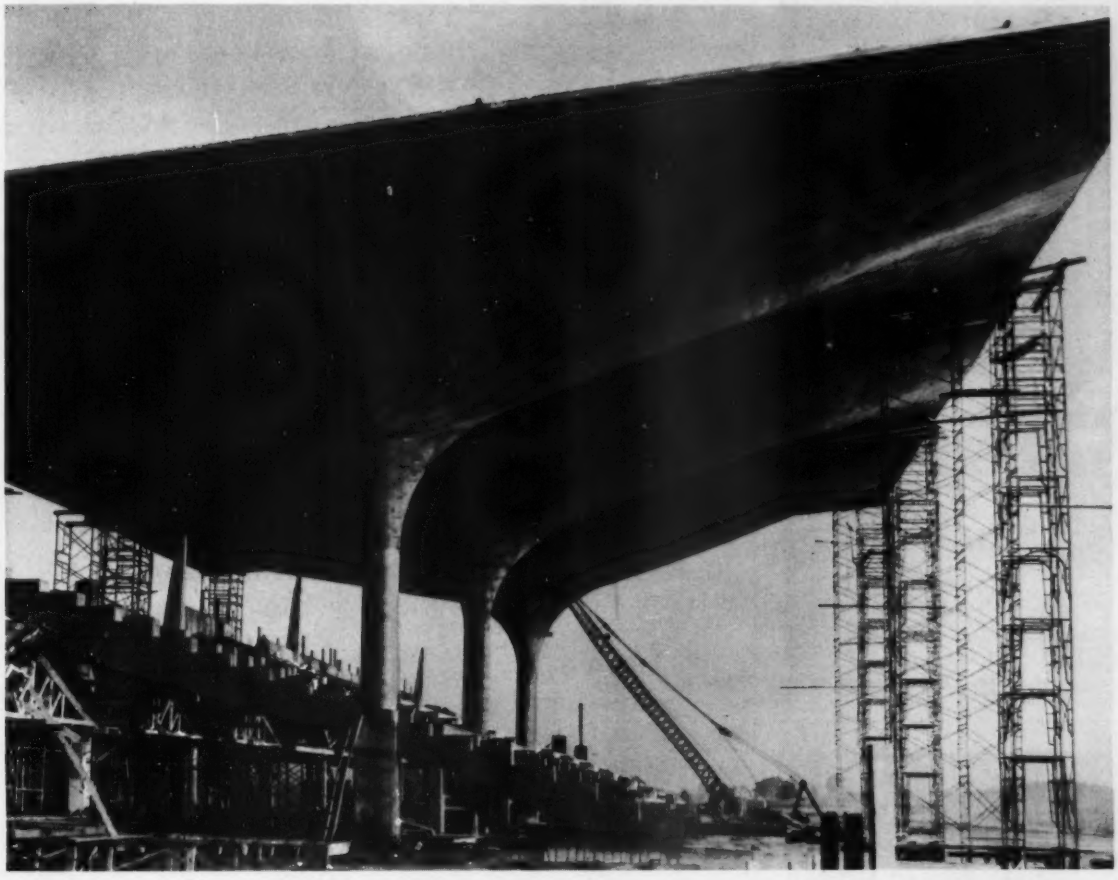
Owner: Scioto Downs, Inc., Columbus, Ohio; Architect: Kellam & Foley, Columbus, Ohio; Structural Engineer: Gensert & Williams, Cleveland, Ohio; General Contractor: Sheaf Construction Co., Columbus, Ohio; Concrete Supplier: Anderson Concrete Corp., Columbus, Ohio.



PLASTIMENT speeds placement of thin shell concrete

The nation's largest hyperbolic paraboloids roof the grandstand for new Scioto Downs Race Track in Columbus, Ohio. Each 400-ton shell is 60 x 116 feet and stands on a single column. 6½- and 7-bag mixes were used with slumps at 2" or less.

Plastiment provided low slump workability and stability during placement on the steeply sloping surfaces.

Early strength gains enabled the contractor to strip forms in 7 days. Strengths in 7 days averaged 3600 psi for the 6½-bag mix and 4700 psi for the 7-bag mix. Plastiment was used in proportions varying from 2 fluid ounces to 4 fluid ounces per sack of cement to provide uniformity with varying ambient temperatures.

Plastiment features are detailed in Bulletin PCD-59. Ask for your copy. District offices and dealers in principal cities; affiliate manufacturing companies around the world. In Canada, Sika Chemical of Canada, Ltd.; in Latin America, Sika Panama, S. A.

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Please send literature on EFCO Footing Forms, and address of nearest sales office (there are 28 coast-to-coast).

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The only Stake with a spiral arrangement of nail holes providing 24 prelocated nail entry points insuring a positive nailing position regardless of stake rotation and it drives straight in any ground.

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- Reuse 100 times
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products

For additional information circle matching key number on reader service card on page 168A.

grinder 625

A concrete grinder is designed for home builders, floor tile installers, industrial maintenance operations, rental yards and wherever light concrete grinding is necessary. Overall height is 37 inches with a width of 15 inches and an overall length of 19½ inches. The model features the Pelican Pak which provides easy storage for grinding stones. It can be used for grinding dry concrete slab, rain pitted slab, joints, high spots and ridges and will remove trowel marks and surplus concrete and plaster. Equipment Development Co., 2700 Garfield Ave., Silver Spring, Md.

repair material 626

Folder describes a dense, nonporous, self-curing plastic that can be buttered on at only ⅛- to ¼-inch thickness on top of existing concrete, brick, metal or wood surfaces. It can be used for a complete new overlay or for repair of damaged floors. It is said to give maximum resistance to strong acids, alkalies, chemicals, oil and grease and to be so hard that heavy trucks and loads cannot harm it. Quick curing causes little interference with normal operations. Stonhard Co., 1306 Spring Garden St., Philadelphia, Pa.

admixture 627

Photographs, tables and graphs illustrate a technical bulletin entitled "Reduction of Water in Concrete Mixed by Chemical Admixture; Effect on Properties" which will be of interest to contractors and engineers engaged in concrete construction. Dewey and Almy Chemical Division, W. R. Grace & Co., Cambridge, Mass.

release coating 628

Folder describes a release coating for use on concrete forms and other equipment where there is a concrete sticking problem. Material is said to improve adherence of paint to concrete and to seal surface of wood forms. Re-use of forms without recoating is another advantage claimed. The product chemically displaces water and may be used on forms not completely dry. The Thomas Co., 1647 Hennepin Avenue, Minneapolis, Minn.

protective coatings 629

Coal-tar protective coatings are described in a 13-page illustrated booklet. Primarily moisture barriers and impervious corrosion proofers, the coatings are particularly suitable for application on buried or immersed steel and concrete structures. Detailed specifications, resistance properties and typical uses are included. Allied Chemical Corp., Plastics and Coal Chemicals Div., Box 75-W, 40 Rector St., New York, N. Y.

repair material 630

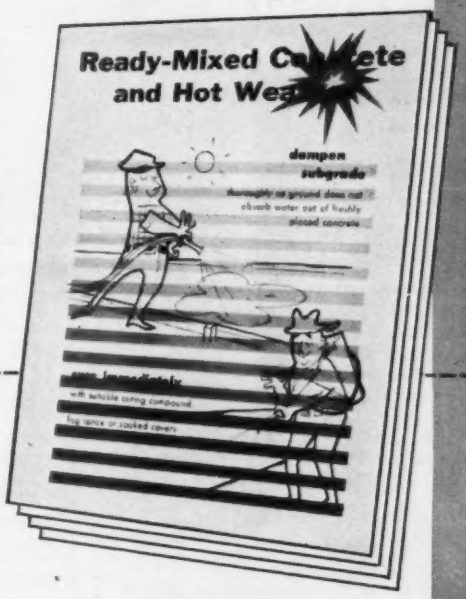
An epoxy resin polysulfide polymer based material is designed for repairing spalled areas, broken slabs and cracks in concrete, bonding new concrete overlays to existing surfaces, bonding precast concrete to existing surfaces and resurfacing existing concrete. The material is said to offer high resistance to wear and impact, to be completely waterproof, and unaffected by temperature, oils, greases, acids, alkalis and other chemicals. It adheres to moist or wet surfaces and will not shrink or expand. W. F. Macklin Co., 336 Taft St., N.E., Minneapolis, Minn.

For quality concrete... protect it from water losses!

Properly mixed concrete has just the right amount of water in it. Hot, dry subgrade absorbs water needed in the mix. Dampen subgrade thoroughly before placing concrete.

And in hot weather, start curing concrete right after finishing operations. Simple tips like these can spell success in building quality concrete. Keep them in front of your crews by using the colorful posters supplied by PCA.

There is a set of four—yours for the asking. They cover hot or freezing weather, drying winds and excess water. Write for yours today. (U. S. and Canada only.)



Quality Reminder posters, 22" x 17", 3 colors, Sets of 4 are free.

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A national organization to improve and extend the uses of concrete

Please send a free set of Quality Reminder posters.
I could also make use of ( ) additional sets.

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CITY_____ STATE_____

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Circle 609 on reader service card

AT LAST

A REALLY GOOD CONCRETE CHUTE

★ Solid Steel
★ Round Bottom
★ High Strength
★ Light Weight

(67 LBS.)

ONLY $28.75
12 FT. LENGTH

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Please rush ..... High-Strength Concrete Chutes. (ENCLOSE CHECK OR MONEY ORDER)

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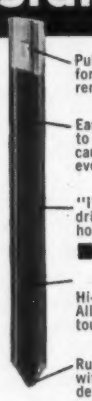
CITY _____ STATE _____

SYMONS Steel Stake

Can Be Reused Indefinitely

Drives easily into hard earth. Can be used for practically any type of stake work. This popular item is available in 12", 18", 24", 30", 36" and 42" sizes.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Easily secured to lumber—can be nailed every 1" O.C.
"I" beam design drives easier, holds best
Hi-Carbon Alloy Steel tough to bend
Rugged point with minimum deflection

Symons

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products

For additional information circle matching key number on reader service card on page 168A.

plywood form panel 631

High density overlaid plywood concrete form panel is designed expressly for forming jobs that require the greatest possible number of reuses or flawlessly smooth architectural concrete. Overlay is an irreversible thermosetting phenolic resin permanently fused to panel. It is said to offer greater resistance to alkaline conditions and to be unimpaired by continuous and prolonged contact with wet concrete. St. Paul and Tacoma Lumber Co., Tacoma, Wash.

watertight concrete 632

A factual summary of authoritative information on the design and specification of watertight concrete is given in a 6-page bulletin. Discussion covers the basic requirements for watertight concrete and tells how to reduce shrinkage, bleeding and segregation to produce strong, durable structural concrete that is highly resistant to the penetration of water. Master Builders Co., Cleveland, Ohio.

1960 spring bulletin 633

A complete line of trowels as well as many other tools for construction are illustrated in a new spring catalogue. Prices and order forms are included. Goldblatt Tool Co., 1910 Walnut St., Kansas City, Mo.

finisher-float

Bulletin 60153 describes a combination finisher-float for concrete surface finishing. The machine is said to produce surface results to meet the most exacting specifications. Features listed: infinite frame adjustability, hydraulically-controlled, 16-inch rear metering screed, and 30-inch wide pan float for final finish which eliminates hand finishing. Chain Belt Co., Milwaukee, Wisc.

sealer 635

Application and test data on product for curing, sealing and dust-proofing newly-placed concrete surfaces in one operation is given in a 4-page brochure. Material is a blend of synthetic rubber resins in fast evaporating solvents and is said to produce a transparent hard glossy film to protect floor from traffic, water, mild acids and alkalies. It promotes water retention and complete hydration of cement and minimizes staining on terrazzo and concrete. Sonneborn Chemical & Refining Corp., 404 Park Ave., So., New York, N. Y.

bonding agent

An epoxy structural adhesive in liquid form for use before applying new concrete or paste form for bonding solid materials together is described in a folder. Recommended for patching, filling cracks and holes, grouting, anchoring bolts and attaching solid objects, it is said to provide a bond stronger than concrete. Adhesive Engineering, 1411 Industrial Road, San Carlos, Calif.

carpeting on concrete 637

Adhesive bonding of hardwood strips to concrete and slate floors for wall-to-wall carpet installations has resulted in considerable savings in both initial and upkeep costs according to the manufacturer. Water used in washing rugs will not loosen the bond and the adhesive prevents wood from rotting. Material is applied to the concrete with a ⅛-inch trowel about 2 inches wide and the hardboard put down using a back and forth motion to break any skinning of the adhesive. A 48-hour drying period assures complete curing for an efficient wood-concrete bond. Miracle Adhesives Corp., Bellmore, Long Island, N. Y.

products

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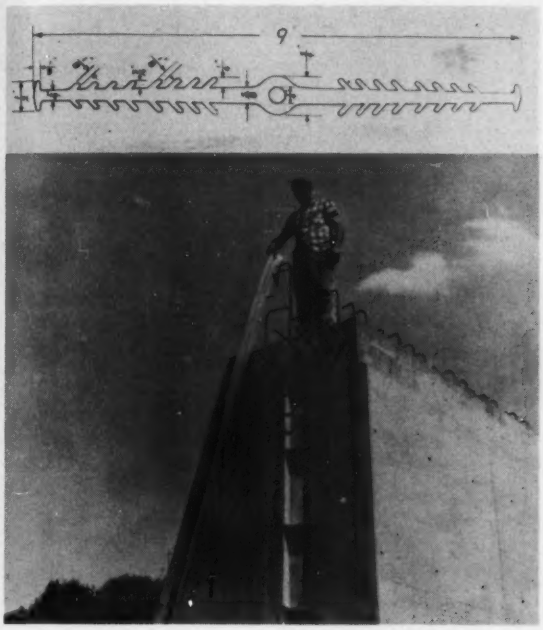

plastic waterstop 638

Picture shows bridge abutment on Worcester Expressway in Massachusetts. Adjacent section of wall will connect where reinforcing bars point toward camera. Waterstop in worker's hand will be bonded when parapet wall is added on top of structure (where vertical reinforcing hooks appear) to give a continuous water seal. Inset shows schematic cross section of waterstop with angle ribbed design said to give greater holding power in concrete and ruggedness to withstand extreme hydrostatic pressures. Other features claimed: superior elongation, flexure, tear resistance, and easy installation and splicing. Material is a polyvinyl chloride resin which is compounded with a special polymer-type plasticizer and extruded. William Brand-Rex Div., American Enka Corporation, Concord, Mass.

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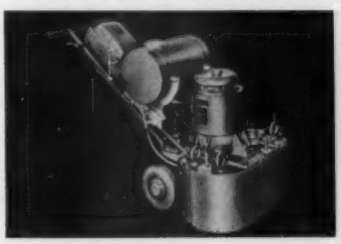

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products

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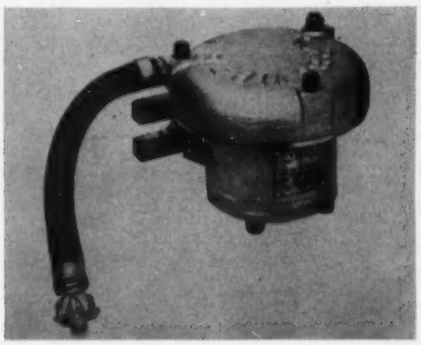
1. Place the panels side by side, slip an adapt-a-clamp over the brackets on the adjoining panels.
2. Slip the tie-rod through the slots in the clamp.
3. Slide the pin into the proper tie-rod hole for desired pouring thickness.

clamping system 639

Clamping system is claimed to cut form erection time by at least 25 percent, to be less expensive than previous hardware, to contain fewer components per panel and to produce excellent finished walls. Rigid panels are maintained by permanently attached metal reinforcing channels. May be purchased complete with panels or hardware may be used on existing panels. Rocform Corp., 15160 W. Eight Mile Rd., Detroit, Mich.



pneumatic vibrator 640

A high speed, pneumatic external vibrator with simplified construction utilizes a unique turbine wheel for its power source and exceptional bearing capacity according to the manufacturer. Through its high speed of 10,000 rpm or more it is said to develop forces of well over a ton and to be particularly adapted for prestressed concrete construction and related industries. Viber Co., 726 S. Flower St., Burbank, Calif.

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Index to Advertisers

Challenge-Cook Bros. 172
Colorado Fuel & Iron Corp. 169
Concrete Transport Mixer Co. ..... inside front cover
Frank D. Davis Co. 184
Dee Concrete Accessories Co. 180
Dewey and Almy Chemical Division ..... inside back cover
F. W. Dodge Corp. 171
Dotmar Industries 178
Duraform, Inc. 182
Economy Forms Corp. 180
A. C. Horn Companies 183
Larsen Products Corp. 174
Maginniss Power Tool Co. 168
National Concrete Contractors Assn. 168A
Patent Scaffolding Co. 167
Portland Cement Association 181
Sika Chemical Corp. 179
Stow Manufacturing Co. 170
Symons Clamp & Mfg. Co. ..... 173 & 182
Terrazzo Machine & Supply Co. 183
Thor Power Tool Co. 166
Truck Mixer Manufacturers Bureau 175
Universal Form Clamp Co. 177
Wyandotte Chemicals Corp. 176